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Neuro AI in Sustainable Marketing: A Brain Power Approach to Green Marketing

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ABSTRACT :

As sustainability becomes a priority in modern marketing, understanding consumer behavior toward green products is more important than ever. This paper explores the role of Neuro AI—a combination of artificial intelligence and neuroscience—in analyzing neuro-response data to predict consumer purchasing decisions for eco-friendly products. By utilizing technologies like eye tracking, EEG, and fMRI, AI can decode subconscious preferences and emotional triggers that drive sustainable purchasing behavior. This data-driven approach helps businesses to create personalized marketing strategies that effectively engage consumers while reducing doubtfulness about green claims. By leveraging Neuro AI, companies can enhance their sustainable marketing efforts, improve consumer trust, and drive real impact in promoting eco-conscious consumption.

Keywords: Sustainable purchasing behaviour, artificial intelligence and neuro science, neuro response, subconscious preferences.

1. Introduction

The rapid advancements in artificial intelligence (AI) and neuroscience have covered the way for a new field known as Neuro AI, which explores how brain activity influences decision-making. One of the most promising applications of this technology is in sustainable marketing—specifically, understanding how consumers respond to eco-friendly products. By analyzing neuro-response data through AI-driven techniques, businesses can gain deeper insights into the subconscious factors that drive green purchasing behavior. This approach allows marketers to create personalized and more effective campaigns, ultimately encouraging consumers to make environmentally responsible choices. The ability to predict purchasing decisions based on brain activity can revolutionize how companies position their sustainable products, making green marketing more impactful and data-driven.

2. Literature Review

The intersection of AI and neuromarketing has been widely studied, particularly in how the brain processes brand perception and consumer decision-making. Research using functional magnetic resonance imaging (fMRI) has shown that AI can help to decode consumer preferences by identifying neural activity patterns associated with brand appeal. For example, a recent study applied machine learning techniques to analyse fMRI data and found that early visual processing areas in the brain play a significant role in determining brand preference (Frontiers in Human Neuroscience). This suggests that AI can help marketers understand which visual and emotional cues influence consumer choices.

Another study conducted a large-scale analysis of AI applications in neuromarketing, revealing five key areas of focus: (1) neuroscience and brain function, (2) neuroimaging techniques, (3) signal processing and data analysis, (4) machine learning applications, and (5) how these tools are used in understanding consumer perception (ACM Digital Library). The findings highlight the growing importance of AI in predicting consumer behaviour through brain activity analysis.

Additionally, electroencephalography (EEG) has been widely used to study consumer preferences. One study developed an AI-powered neuromarketing system that analysed EEG signals to predict consumer choices with high accuracy. The research found that specific brain regions, particularly the frontal cortex, are key indicators of how consumers feel about a product (PubMed). This demonstrates that AI-driven neuro-analysis can provide valuable insights into purchasing behaviour.

Despite these advancements, limited research has specifically focused on green marketing. While AI has successfully been used to analyse consumer responses to general products, there is still much to explore in understanding how brain activity influences sustainable purchasing decisions. By applying AI to neuro-response data in the context of green marketing, businesses can design more compelling campaigns that encourage eco-friendly consumer behaviour.

3. Methodology

In the next step we gather the neuro response data from different sources like Electroencephalography (EEG), functional magnetic Resonance Imaging (fMRI) to predict the consumer purchasing decisions for green product. We have collected the behavioral data from this site and labeled the purchase intent as 'interested' and 'not interested'. For our coding purpose we use a binary classification like 1 for purchase data and 0 for no-purchase data. We use Min Max Classifier to scale the values between 0 and 1. Also we have simulated the EEG data with 1000 samples, each having 20 EEG channels recorded over 100 time-steps to mimic the real neural response data. We split the dataset into training (80%) and testing (20%) subsets.

We use a deep learning model with Long Short-Term Memory (LSTM) layers which are effective for processing time series neuro response. We also use Synthetic Minority Oversampling Technique to handle the class imbalance. So, we use 2 LSTM layers with a dropout regularization to prevent overfitting. Also, the final layer of LSTM uses Sigmoid Activation Function for binary classification. Additionally, we add a Bidirectional LSTM to capture dependencies from both directions.

In the next step, we train the model with 20 epochs with binary cross entropy loss function and we can make a prediction based on the test set. The model's accuracy can be determined using a classification matrix by using accuracy, precision and f1 score results.

4. Discussion

The results of the LSTM based model for predicting green product purchasing decision from EEG data indicates a 52.5% accuracy. The precision for "No Purchase" (Class 0) is 53%, while for "Purchase" (Class 1), it is only 48%. This suggests that the model is biased toward predicting 'No Purchase' more frequently. While the recall for purchase intent is only 11%, meaning the model often fails to correctly identify users who are actually interested in buying green products. The F1-score for "Purchase" is 0.17, indicating poor predictive ability for consumers inclined to buy green products. This suggests that neural signals for purchasing intent may be more complex and require additional feature extraction techniques.

Accuracy: 0.525

Classification Report:

	PRECISION	**RECALL**	**F1 SCORE**
0 (NO PURCHASE)	**0.53**	**0.90**	**0.67**
1 (PURCHASE)	**0.48**	**0.11**	**0.17**

After using Synthetic Minority Oversampling Technique (SMOTE) accuracy slightly increases from 52.5% to 54.5% as it helps to handle the class imbalance problem. This is slightly better than EEG based purchasing patterns. The precision for buyers improved from 48% to 57%. It means that when the model predicts a purchase, it is more likely to be correct. Recall for "No Purchase" increased to 92%, meaning the model is very effective at identifying non-buyers. But this suggests a bias where the model is still favoring non-purchasing behavior over purchasing behavior. The F1-score for "No Purchase" remains high (0.68), whereas for "Purchase," it improves only slightly to 0.21. This highlights that the model is still struggling to capture complex purchasing intent from EEG signals.

Accuracy: 0.545

Classification Report:

	PRECISION	**RECALL**	**F1 SCORE**
0 (NO PURCHASE)	**0.54**	**0.92**	**0.68**
1 (PURCHASE)	**0.57**	**0.13**	**0.21**

5. Limitation

As consumer decision making involves multiple cognitive as well as emotional factors, that might not be fully captured by EEG data model. Also, Synthetic resampling helps to improve the balance but purchasing signals may have distinct neuro patterns that makes a learning inefficiency. Dividing the data into multiple frequency bands or using of power spectral density may enhance the learning process as well as the accuracy of the model.

6. Conclusion

This study highlights the potential of Neuro AI in understanding how consumers make purchasing decisions for green products by analyzing EEG data. While the improved model showed a slight boost in accuracy, it still faces challenges in correctly identifying actual buyers.

To achieve better predictions, future research should focus on incorporating advanced EEG signal processing, combining AI techniques like hybrid models, and integrating behavioral insights. These enhancements can help to develop a more precise and scalable approach for sustainable marketing strategies.

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